Proceedings 5th World Rabbit Congress, 25-30 July 1992, Corvallis – USA, 213-223.

PHENOTYPIC ANALYSIS OF A SYNTHETIC POPULATION OF RABBITS, SELECTED FOR THE GLOBAL OBJECTIVE OF LITTER WEIGHT AT 60 DAYS OLD THROUGH OVERLAPPING GENERATIONS

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ABSTRACT

A phenotypic analysis of a population of rabbits subjected to a selection process for a global objective, litter weight at 60 days old in overlapping generations, has been carried out. Variance analysis for the characters of litter growth and size have shown the influence of the doe's year of birth on them all except for the total number of newborns and the number of alive newborns. Regression coefficients have been calculated among the studied characters and the doe's year of birth. The only coefficients that have proved to be positive and different from zero are those corresponding to the number of alive newborns, the individual weight at 60 days, and the daily post-weaning growth. Between the years 1983 and 1989, an increase of 9.4 gr has been achieved in the daily post-weaning growth, with no negative effects on the prolificacy factor.

1.- INTRODUCTION

The objective of the current work is to achieve a phenotypic analysis of the productive characters of the population subjected to selection at our unit.

2.- MATERIAL AND METHODS

The constitution of the flock and the selection methods were described in former publications (RAFEL et al., 1988. RAFEL et al, 1990). Animal management and farming conditions are those described by RAFEL et al. (1990) and UTRILLAS et al. (1992).

2.2- Methods of analysis

A reference file has been used containing a total of 5071 parturitions, which were produced between the first of January and 31 December 1990. The parturitions produced by does born in 1990 have been eliminated from this index, because many of those does were still active at the moment when the analysis was done. On the

This work has been realized in the frame of scientific cooperation with the INRA (France) SAGA, Toulouse and IRTA and the agreement IRTA-Diputació of Barcelona.

other hand, the 0 results for the studied variable have been eliminated from each analysis; therefore, for the study of the NV, litters with NV=0 have been eliminated, for the NT, litters with NT = 0 have been eliminated, and so on.

The following variables have been studied:
- NV : number of young rabbits born alive
- NT : number of young rabbits born, total
- ND : number of young weaned rabbits (32 days old)
- N2C : number of young rabbits present at the second control (60 days old)
- PD : litter weight at weaning (32 days old)
- PID : individual weight of young rabbits at weaning (PID=PD/ND)
- P2C : litter weight at second control (60 days old)
- PI2C: individual weight of young rabbits at second control. (PI2C=P2C/N2C).
- CRX : individual daily growth of young rabbits between weaning and second control

The variation factors, which were studied in former publications (RAFEL et al, 1990. UTRILLAS, 1990), are the following ones:

- AN: Year of birth of the doe that produced the syudied parturition.

- TR: Trimester when parturition was produced

- EFA: Physiological condition before parturition. Four conditions have been established:

  0 : primiparous doe.
  1 : there is no point of connection between the gestation of the litter under study and the lactation of the former litter
  2 : the connection between the gestation of the litter under study and the lactation of the former litter occurs between 5 and 8 days.
  3 : the connection between the gestation of the litter under study and the lactation of the former litter occurs between 20 and 24 days.

- EFP: Physiological condition after parturition. Four conditions have been established:
  0 : female without data from the last mating, and therefore with an unknown EFP.
  1 : there is no connection between the lactation of the litter under study and the gestation of the next litter.
  2 : the connection between the lactation of the litter under study and the gestation of the next litter occurs between 6 and 8 days.
  3: the connection between the lactation of the litter

under study and the gestation of the next litter occurs between 20 and 24 days.

The EFP cannot affect the characters NT and NV because its influence is exerted after the litter's birth, and therefore it has not been included in the model used to study the previously mentionned traits.

- TCR: size of reconstituted litter. The number of young rabbits is limited to 8 as a maximum among first parturition litters and to 10 among the remaining ones. TCR is therefore the number of young rabbits definitively remaining in the litters after these eliminations have been made. This effect has been included as a covariable only with the models used to study the effect of PID and PI2C.

The effects of the variation factors on each variable have been studied through a process of variance analysis, with General linear models (SAS/STAT, 1988).

For the variance analysis, 3 different models have been used:

1.- For the characters NT and NV.

$$y_{ijkl} = AN_i + TR_j + EFA_k + e_{ijkl}$$

2.- For the characters ND, N2C, PD, P2C, and CRX.

$$y_{ijklm} = AN_i + TR_j + EFA_k + EFP_l + e_{ijklm}$$

3.- For the characters PID and PI2C.

$$y_{ijklm} = AN_i + TR_j + EFA_k + EFP_l + b.TCR_{ijklm} + e_{ijklm}$$

Regression coefficients between corrected means of each variable and the doe's year of birth have been calculated (SAS/STAT (1988).

3.- RESULTS AND DICUSSION

All the models that have been used for the variance analysis are significative to one per cent.

Table 1 shows the number of parturitions used for each analyisis, that varied according to the number of registries that had value = 0 for the paramater under study, and that were therefore removed.

Table 2 shows corrected means for the variation factors, per year of birth of breeder does which have given birth to the parturition under study. Most selection experiments with separated generations give the results of the phenotypic analysis per each generation (ROUVIER et al., 1980. MATHERON and POUJARDIEU, 1984.

DE LA FUENTE et al., 1986.). However, with overlapping generations this is difficult, and in the current work they have been given per year of birth of the doe because this is the simplest way to observ and evaluate the evolution of the results. In two former publications (UTRILLAS et al., 1989. RAFEL et al., 1990) where the same population was studied, the results were given per year of parturition, and the evolution of these was similar to the one reflected in the current work.

Table 3 shows regression coefficients between characters under study and the does' year of birth (AN).

Prolificacy characters

Number of total newborns: The doe's year of birth does not have any influence on the number of total newborns. The test of separation of means only detects differences between the 9.29 NV of year 1983 and the 9.74 of year 1988. Regression coefficient between NT and AN is not significantly different from 0.

Number of alive newborns: Although the variance analysis shows no influence of the doe's year of birth on the number of alive newborns, the regression coefficient between NV and AN is positive and significantly different from 0 ($p<0,05$), which shows a tendency to increase the number of NV throughout the years. Figure 3 shows the corresponding regression line. During an experiment with separated generations, where the only selection done was per daily growth, a negative regression coefficient between NV and the number of generation was observed by DE LA FUENTE et al. (1986). Contradiction between this result and those of the current work may be explained through the process carried out in two stages where, in our case, before selecting per growth, a selection is made of those litters with a bigger weight at weaning, and by the fact that this character depends as much on young rabbits weight as on their number.

Number of weaned rabbits: The number of weaned rabbits depends on the doe's year of birth ($p<0,01$), but the evolution of ND values is not continuous and shows oscillations. This is probably why the regression coefficient between ND and AN is not significantly different from 0. In the previously mentionned publication (DE LA FUENTE et al, 1986), the regression coefficient between ND and the generation number was negative; in our case this is not so because of the previously mentionned reason concerning the number of alive newborns.

Number of young rabbits present at second control: The number of young rabbits present at the second control depends on the doe's year of birth ($p<0,01$), with the same oscillations that in the number of ND, but in this case the regression coefficient between N2C and AN is negative although it is not significantly different from 0.

The characters NV, ND and N2C follow a parallel evolution

throughout time, which is different from the one followed by NT. The NT trait is closer to the direct expression of female genes, whereas NV, ND and N2C are more influenced by the environment. This fact could explain the oscillations of these three characters. Environmental and managemental improvements, as much as the appropriate selection method have been the cause of this character not decreasing with time even if the selection has been made for growth.

Growth characters

Litter weight at weaning: There is an influence of the doe's year of birth on the litter weight at weaning ($p<0,01$), but the evolution, as much as with the other parameters under study is not continuous and shows oscillations. The biggest differences were found between the 5152 grs of 1983 and the 5842 grs. of 1986. Regression coefficient between PD and AN is not significantly different from 0.

Individual weight at weaning : The influence of the doe's year of birth on the litter weight at weaning is similar to the one of the weight at weaning, with significant differences at the level of AN ($p<0,01$) and a regression coefficient between PID and AN not different from 0. In the publication previously mentionned, a positive regression coefficient between PID and the generation number was observed by DE LA FUENTE et al (1986).

Weight of the litter at the second control : The weight of the litter at the second control depends on the doe's year of birth ($p<0,01$) and, although it shows an increasing evolution which reaches a maximum of 14844 grs in the year 1988, the regression coefficient between P2C and AN is not significantly different from 0. Until the year 1986, P2C shows the same evolution as PD, but P2C continues to increase until the year 1988, when a decrease of more than one kg per litter is found, as a result of both N2C and CRX decreases.

Individual weight of litter at second control : The doe's year of birth has an influence on the individual weight at the second control ($p<0,001$). The PI2C are always different from one year to the other ($p<0,05$) except from 1985 to 1986. The regression coefficient between PI2C and AN is positive and different from 0 ($p<0,05$), which shows a tendency towards PI2C increase throughout the years. Figure 2 shows the correspondent regression line. This result is similar to the one observed by DE LA FUENTE et al. (1986) between the individual weight at 77 days old and the number of generation.

Daily growth : The daily growth of young rabbits depends on the doe's year of birth ($p<0,01$) and increases from 34.9 grs in the year 1983 to 43.5 grs in the year 1989, with a maximum of 44.2 grs in the year 1988. CRX increases significantly by 10 grs between 1983 and 1988, and decreases by 0,8 grs in 1989. This increase probably comes from the selection process, besides the improvement

in environmental and managemental conditions. The regression coefficient between CRX and and AN is positive and different from 0 ($p<0.01$), which shows a strong tendency towards a gain in daily growth throughout the years that the experiment lasts. Figure 3 shows the corresponding regression line.

4. - CONCLUSIONS

With the selection method used and the described managemental conditions:

1.- Daily post-weaning growth has been increased by 9.4 grs with no negative effects on the prolificacy characters.

2.- Litter weight at 60 days old has increased in a continuous way throughout the years, until 1988. In 1989 it has decreased as a result of a lesser growth (- 0,7 gr.) and a decrease in the number of young rabbits present at the second control (-0.79).

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TABLE 1

NUMBER OF OBSERVATIONS INVOLVED IN THE STUDY OF EACH CHARACTER.

CHARACTER / YEAR	N.V.	N.T.	N.D.	N2C	P.D.	P.I.D.	P2C	PI2C	CRX
83	461	471	434	426	430	430	426	426	426
84	551	556	524	524	524	524	524	524	524
85	694	720	630	629	630	630	629	629	629
86	735	746	673	670	671	671	670	670	670
87	650	672	614	614	614	614	614	614	614
88	746	766	770	706	707	707	706	706	706
89	830	847	787	786	787	787	786	786	786
TOTAL	4.667	4.778	4.368	4.355	4.363	4.363	4.355	4.355	4.355

TABLE 2

CORRECTED MEANS OF THE STUDIED CHARACTERS. EXPRESSED AS DOE'S YEAR OF BIRTH.

CHARACTER / YEAR	N.T.	N.V.	N.D.	N2C	P.I.D.	P.D.	PI2C	P2C	CRX
83	9.23b	8.89ab	7.61ab	7.29bc	703d	5152cd	1688e	12127f	34.9f
84	9.26ab	8.98ab	7.81a	7.61ab	703d	5282cd	1724d	12952e	36.6e
85	9.48ab	8.81b	7.46bc	7.19c	795a	5743cb	1899c	13519d	39.4d
86	9.58ab	8.95ab	7.80a	7.57ab	775b	5842a	1910c	14276c	40.7c
87	9.51ab	8.98ab	7.57b	7.42bc	760b	5541c	1968a	14379c	44.0ab
88	9.74a	9.16a	7.93a	7.81a	744c	5642bc	1940b	14844a	44.2a
89	9.61ab	9.11a	7.39c	7.02d	732c	5201d	1908c	13223b	43.5b
Signification level of AN	N.S.	N.S.	**	**	**	**	**	**	**

(** P<0,01). (N.S. = Non significant). (The quantities that are followed by, at least, one equal letter do not have statistically significant differences at the level of P<0,005).

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TABLE 3.

REGRESSION COEFFICIENTS BETWEEN THE STUDIED CHARACTERS AND THE DOE'S YEAR OF BIRTH.

CHARACTER	REGRESSION COEFFICIENT	
N.T.	0.0496 ± 0.0248	N.S.
N.V.	0.0425 ± 0.0162	*
N.D.	0.0604 ± 0.0696	N.S.
N2C	-0.0064 ± 0.0560	N.S.
P.D.	16.6071 ± 54.4166	N.S.
P.I.D.	4.7857 ± 6.9078	N.S.
P2C	283.2857 ± 148.8191	N.S.
PI2C	41.4643 ± 13.1713	*
CRX	1.6286 ± 0.2462	**

(* P <0.05) (** P < 0.01) (N.S. = Non significant)

FIGURE 1

REGRESSION YOUNG RABBITS BORN ALIVE

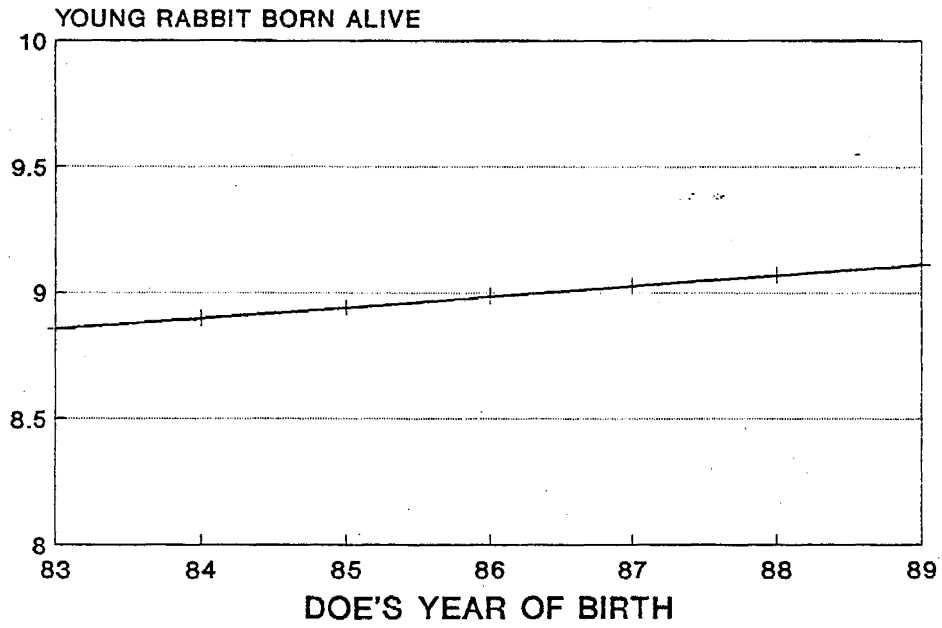

FIGURE 2

REGRESSION INDIVIDUAL WEIGHT OF RABBIT SECOND CONTROL

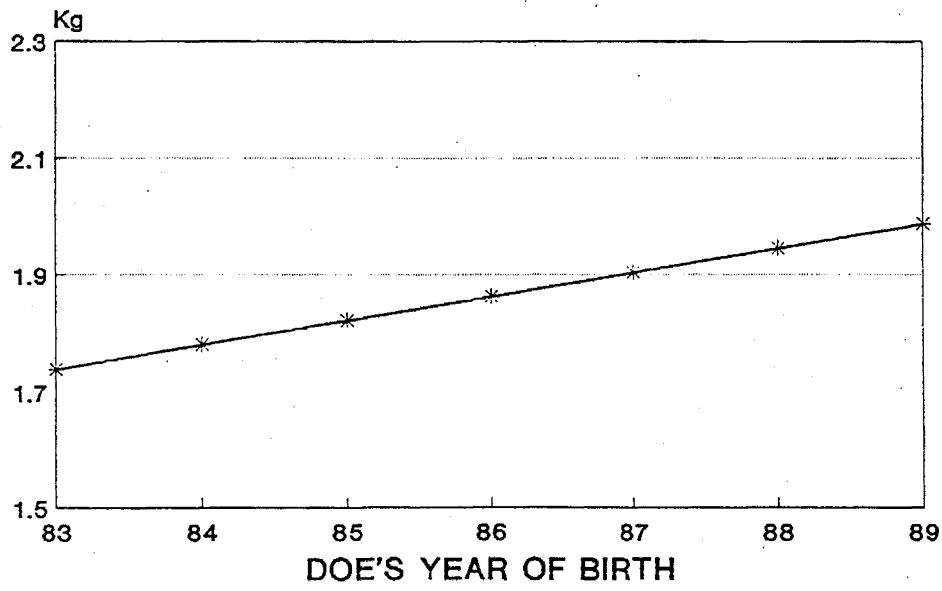

FIGURE 3